California High-Speed Train Project

TECHNICAL MEMORANDUM

Capital Cost Estimating Methodology for the 15% Design Level TM 1.1.19

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Released by:	*Signed document on file* Hans Van Winkle, Program Director	14 Jan 11 Date

Revision	Date	Description
0	20 July 09	Issued for 15% Design, R0
1	11 January 11	Updated Roles and Responsibilities, and WBS

System Level Technical and Integration Reviews

The purpose of the review is to ensure:

- Technical consistency and appropriateness
- Check for integration issues and conflicts

System level reviews are required for all technical memoranda. Technical Leads for each subsystem are responsible for completing the reviews in a timely manner and identifying appropriate senior staff to perform the review. Exemption to the System Level technical and integration review by any Subsystem must be approved by the Engineering Manager.

System Level Technical Reviews by Subsystem:

Systems:	NOT REQUIRED _____ __ _____ Richard Schmedes	DD Month YY Date
Infrastructure:	NOT REQUIRED _____ _____ John Chirco	DD Month YY Date
Operations:	NOT REQUIRED _____ _____ Paul Mosier	DD Month YY Date
Maintenance:	NOT REQUIRED _____ _____ Paul Mosier	DD Month YY Date
Rolling Stock:	NOT REQUIRED _____ _____ Frank Banko	DD Month YY Date

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ABSTRACT

This technical memorandum describes the Capital Cost Estimating Methodology (CCEM) for the California High Speed Train Project (CHSTP) and provides guidance for preparing and presenting estimated capital costs for the project's 15% Design level. It is expected that a uniform methodology for the preparation of capital costs will promote the development of complete and consistent cost information for the high-speed train alignment and facilities in each of the project's geographic sections.

This document describes the roles and responsibilities for preparing capital cost estimates, defines the estimating tasks, and outlines the procedures and standards that will be used to prepare the capital cost estimates. The methodology for estimating the project's capital costs is required to determine the fiscal requirements for the project and provide necessary information for the cost-effectiveness analysis, project financial planning and implementation.

1.0 INTRODUCTION

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this technical memorandum is to provide guidance for the preparation of reliable and accurate capital cost estimates for the 15% Design level.

This memo describes the preparation of a program wide Capital Cost Estimating Methodology (CCEM) for the California High-Speed Train Project (CHSTP). With its size, complexity, phased design, and number of participants, it is important that the CCEM is flexible enough to be applied at each point in the project development process to appropriately support the tracking, monitoring and control of cost changes through each if the program's design and implementation phases. This document addresses only the capital cost estimating requirements for the 15% Design level. Additional guidelines will be developed for the preparation of capital cost estimates for subsequent phases of the high-speed rail project.

1.2 STATEMENT OF TECHNICAL ISSUE

The guidance in this technical memorandum is intended to address the preparation of a program cost estimate, including construction, acquisition of right-of-way, engineering and management and related costs that may arise during execution of the project.

The CCEM is intended to provide guidelines for accurately and consistently estimating the costs of capital infrastructure and systems for the 15% Design level. It will also provide a framework for defining the scope and technical basis for the estimates, the roles and responsibilities for specific estimating tasks among the project participations, and the structure, organization, and format for reporting capital costs.

1.3 GENERAL INFORMATION

1.3.1 Definition of Terms

Technical terms, acronyms, or other cost estimating terminology specifically used for capital cost estimating purposes, unless otherwise indicated, will follow the standard definition of terms published by the Association for the Advancement of Cost Engineering (AACE) International in their Recommend Practice No. 10S-90 – Cost Engineering Terminology.

The following acronyms used in this document have specific connotations with regard to California High Speed Train system.

Acronyms

AACE	Association for the Advancement of Cost Engineering
CCEM	Capital Cost Estimating Methodology
Authority	California High-Speed Rail Authority
CHSTP	California High-Speed Train Project
ENR	Engineering News Record
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
LCCA	Life Cycle Cost Analysis
O&M	Operating and Maintenance
PMT	Program Management Team
RC	Regional Consultant(s)
SCC	Standard Cost Categories
TM	Technical Memorandum
WBS	Work Breakdown Structure

1.3.2 Units

The California High-Speed Train Project is based on U.S. Customary Units consistent with guidelines prepared by the California Department of Transportation and defined by the National Institute of Standards and Technology (NIST). U.S. Customary Units are officially used in the United States, and are also known in the US as “English” or “Imperial” units. In order to avoid confusion, all formal references to units of measure shall be made in terms of U.S. Customary Units.

Guidance for units of measure terminology, values, and conversions can be found in the Caltrans Metric Program Transitional Plan, Appendice B U.S. Customary General Primer (http://www.dot.ca.gov/hq/oppd/metric/TransitionPlan/Appendice-B-US-Customary-General-Primer.pdf). Caltrans Metric Program Transitional Plan, Appendice B can also be found as an attachment to the CHSTP Mapping and Survey Technical Memorandum.

2.0 DESIGN STANDARDS AND GUIDELINES

2.1 CAPITAL COST ESTIMATING METHODOLOGIES

Estimating methodologies are not static and must be flexible enough to adjust to the needs of the project's stage in the development process. The development process is described by the overall level of engineering design associated with the major development stages defined for the CHSTP:

Development Stage	Engineering Design Completion
Programmatic EIR/S	
Project EIR/S	
15% Design Level	
30% Design Level	
Design-Build	

Each development stage is represented by a range of engineering design completion and influenced by ongoing updates to the ridership demand forecast and associated revisions to estimated system capacity, service design and operating plans. Because of this variability, the appropriate estimating methods or procedures at a given milestone will be based on the actual levels of project engineering and scope definition present at that time. Because the program will be designed in multiple segments, the level of engineering design completed for major high-speed train system elements will be at different levels at any point in time. The goal of using established estimating methodologies is to assure that project estimates are prepared in a consistent and uniform manner, organized and standardized in methods, and formatted in order to facilitate estimate review and reporting.

2.2 POLICY CONSIDERATIONS

2.2.1 Estimating Format

A consistent format is required for the reporting, estimating, and managing of the project's capital costs. This document recommends using standard cost categories (SCC) established by the Federal Railroad Administration (FRA) as part of American Recovery and Reinvestment Act (ARRA) grant application requirements. Preparation of capital costs in SCC format will be required throughout the preliminary design.

2.2.2 Estimating Software

In order to provide for uniformity between numerous corridors and Regional Consultants as well as a consistent platform to allow for anticipated reporting and analysis requirements of the program wide cost estimates, a commercially available database software system will be used for the program-level compilation and reporting tasks performed by the PMT. Regional Consultants have the option of preparing quantity and cost information using any appropriate software for the estimating tasks that are their responsibility. Regional Consultants will be required to present the quantities in Microsoft Excel. Standard Excel templates will be developed for tasks such as quantity takeoffs and provided to all project participants.

3.0 ASSESSMENT AND ANALYSIS

3.1 ROLES AND RESPONSIBILITIES

Project participants will work on different and/or multiple high-speed train corridors and will be working at varying stages of project development concurrently. Recognizing that the development of capital cost estimates involves the execution and coordination of a number of estimating tasks, one of the critical issues is the assigning of roles and responsibilities for these tasks.

The primary project participants that have a role in the Capital Cost Estimating Program are:

- California High-Speed Rail Authority (Authority)
- Program Management Team (PMT)
- Regional Consultants (RC)

Table 3-1 identifies the areas of responsibility for each estimating task, by participant, for the project's 15% Design level.

Table 3-1 Roles and Responsibilities for 15% Design

Task	Estimating Task	15% Design Level		
		Authority	PMT	RC
1	Work Breakdown Structure (WBS)	R	P	-
2	Unit Prices	R	P	R / P
3	Quantity Takeoffs	-	-	P / R
4	Construction Cost Estimate	R	P	R
5	Property Takes and Easement Qty	-	R	P
6	Right-of-Way Cost Estimate	R	R	P
	Rolling Stock Procurement Estimate	R	P	-
9	Program Implementation Add-ons	R	P	-
10	Program Wide Cost Estimate	R	P	-
11	Estimate Validation	R	P	P

Legend: **P** = Perform Work **R** = Review Work

3.2 ESTIMATING TASKS

3.2.1 Task 1 - Work Breakdown Structure (WBS)

This task involves the development of the Work Breakdown Structure (WBS) that will be applied to cost estimating and cost reporting. The WBS for estimating will include a coding system that will be used for estimating elements such as unit prices, quantities, labor, materials, etc. The WBS for reporting includes the development of a coding system that allows the cost estimates to be sorted and presented by elements such as geographic region, political or municipal boundaries, construction package, schedule activity, and similar project elements.

The WBS for capital cost estimates for the 15% Design level is based upon the FRA Standard Cost Categories. The WBS, inclusive of the standard cost categories, is presented in Appendix A.

3.2.2 Task 2 – Unit Prices

This task involves the development of construction unit prices for each of the construction activities that will be identified and quantified from the design documents in accordance with Section 3.5 Cost Estimate Pricing Methods for 15% Design. The development of individual or composite unit prices will be accomplished through the use of historical bid data and by unit cost analysis, as appropriate, using

labor, equipment and material rates. Unit prices will be expressed in current year dollars and will be adjusted to reflect any regional variations typically seen in the state.

The PMT will prepare a list of prototypical unit cost elements and the units of measure to be estimated for 15% Design level, and will develop corresponding unit prices. Appendix B presents the list of cost elements for the 15% Design Level. Regional Consultants will review unit prices and supporting back-up information developed by the PMT and will provide comments as necessary reaching concurrence. If required, project-specific unit cost elements reflecting unique site conditions and configurations will be identified and developed by the Regional Consultants and reviewed by the PMT. Examples of these project-specific unit prices include very high and/or long span iconic bridge structures, grade separations, specific roadway improvements, unique utility relocations, staged construction to accommodate existing rail or vehicular traffic, or restrictive site access conditions in urban areas.

3.2.3 Task 3 – Quantity Takeoffs

This task involves preparing estimated quantities, either by direct measurement and calculation of construction elements that are shown in design drawings, electronically calculated for CADD files or established as an allowance quantity based on professional experience and judgment.

No specific methodology will be prescribed for estimating quantities for the 15% Design level. Regional Consultants shall identify and use the appropriate source and methodology used for quantity take-offs. The intent is to leave a reviewable trail for quantities to be checked or spot-checked by others.

The PMT will develop a template with the 15% Design unit cost items and units of measure that the Regional Consultants will use to record and transmit estimated quantities. Regional Consultants will prepare and transmit final quantities in the Unit Cost Summary template prepared by the PMT. Once construction cost estimates are compiled by the PMT, Regional Consultants will review values and allocation of quantities within the estimates and provide written concurrence that subject estimate represent quantities as intended. An example of the sign-off sheet used in documenting this concurrence is included as Appendix C.

3.2.4 Task 4 - Construction Cost Estimate (including Contingency)

This task involves the assembly and calculation of cost estimates for construction related activities using data developed in Tasks 1-3 and procedures described in Section 3.4 Preparation of 15% Cost Estimates, Section 3.5.4 Base Year and Escalation, and Section 3.5.5 Program Implementation, along with the application of appropriate contingencies as presented in Section 3.5.3 Contingency. The PMT will establish baseline contingencies for major cost categories for the 15% Design level, as presented in Table 3-2. Regional Consultants may adjust contingency values, if appropriate, based on information about each of the project's geographic segments. The analysis and selection of appropriate contingencies will be further supported through application of risk management practices. The PMT will prepare program wide cost estimates based on the contingency values that are agreed upon by the PMT and Regional Consultants.

3.2.5 Task 5 – Property Takes and Easement Quantities

This task involves preparing estimated quantities of impacted properties, either permanent takes or temporary easements, which result from construction, operation, and maintenance of proposed high-speed train alignment alternatives. The identification of property related impacts that need to be quantified must be performed in coordination with the methodology that will be used to develop the right-of-way cost estimates described in Task 6 – Right-of-Way Cost Estimates.

Regional Consultants will be responsible for preparing quantity estimates for property takes and easements.

3.2.6 Task 6 – Right-of-Way Cost Estimate (including Contingency)

This task involves applying professional experience and judgment in the area of property valuation, business damages, and legal and administrative issues as they relate to the estimation of right-of-way costs. The means and methods used to develop these cost estimates will have a direct effect on Task 5 and on how property impacts are identified and quantified.

Regional Consultants will determine appropriate methodologies for determining, quantifying, and estimating real property costs. Regional Consultants will estimate costs to acquire right-of-way and property interests required for the construction, operation, and maintenance of the high-speed train system.

3.2.7 Task 7 – Rolling Stock Procurement Estimate

This task involves estimating the costs associated with the procurement of rolling stock, including both revenue and non-revenue vehicles. Cost estimates for this task will be dependent on the vehicle technology that is ultimately selected.

The PMT will prepare the rolling stock procurement estimate.

3.2.8 Task 8 – Program Implementation Add-ons

This task involves establishing percentage add-on allowances for project related professional services for items such as preliminary and final engineering, project and construction management, agency program management, project insurance, commissioning and testing, and project start-up costs. These allowances will be computed by applying percentage factors to the total estimated construction cost (Task 4), excluding right-of-way and rolling stock costs since the total cost for these two items will include the management and administration costs associated with these activities.

The PMT will prepare the professional service categories and percentage factors.

3.2.9 Task 9 – Assemble Program Wide Cost Estimate

This task involves compiling and maintaining a program wide cost estimate by combining construction costs (Task 4), right-of-way costs (Task 6), rolling stock procurement costs (Task 7), and applying professional services costs (Task 8) to produce an estimate of the overall CHSTP program.

The PMT will prepare the program wide capital cost estimate based on quantities, project-specific unit costs and right-of-way acquisition costs that are prepared by the Regional Consultants.

3.2.10 Task 10 – Estimate Validation

Following preparation of the 15% Design level estimates, cost estimates will advance through a validation process as outlined in Section 3.5.6 Estimate Validation. This task will assemble subject matter experts in the areas of engineering, construction, and estimating to perform an independent review of the scope, assumptions and basis used to prepare the cost estimate. This process will provide a thorough vetting of each cost estimate before it is finalized.

In collaboration, the PMT and Regional Consultants will validate the 15% Design level cost estimates.

3.3 ESTIMATING METHODOLOGY AND STANDARDS

Multiple designers working concurrently on the project's multiple geographic segments requires that common design basis, criteria and standards; engineering assumptions; design guidance; and directive drawings are used to develop high-speed train alternatives and cost estimate quantities used in preparing the cost estimates. The following are guidelines and standards to be used in preparing the 15% Design level cost estimates.

3.3.1 Design Guidelines and Standards

CHSTP estimates shall be based on design guidelines defined in Technical Memoranda that have been issued or are under development. Criteria, guidelines and assumptions used to identify construction activities in capital cost estimates shall be in accordance with all approved technical memoranda and design guidance documents.

3.3.2 Software

Software for developing and preparing program capital cost estimates include standard spreadsheet programs, such as Microsoft Excel, or commercially produced database estimating programs.

No specific software is prescribed for the estimating quantities and producing cost estimates for the 15% Design level. However, Regional Consultants shall prepare quantities and transmit the information

in a template provided by the PMT. This will provide uniformity between high-speed line segments performed by the Regional Consultants as well as provide a platform to allow for consistent input into program-level estimates.

The PMT shall compile and prepare segment specific and the overall program wide cost estimates using a commercially available database program that will allow for the anticipated reporting and analysis needs of the program-wide cost estimates. The database software will be used primarily as a tool to compile quantities, apply unit prices, contingencies and for reporting.

3.3.3 Coordination with Project Control Functions

There are a number of project controls disciplines that are typically associated with capital cost estimating that must be considered during the development of the CCEM. These include construction scheduling, cost and change control, and risk management. Regional Consultants shall be responsible for the coordination between the project control functions, including preparation of construction schedules. for their respective segments.

3.4 PREPARATION OF 15% COST ESTIMATE QUANTITIES

The following information in the 15% Design level cost estimate quantities shall be prepared by the Regional Consultants for each project segment:

- Letter of transmittal
- Basis of estimate
- Estimate reconciliation (if previous estimate exists)
- Estimate summary
- Details of estimate
- Quantity takeoff summary

A description of the information to be included is summarized in the following section.

3.4.1 Basis of Estimate

The Basis of Estimate provides specific information related to the estimate and shall provide the following information:

- Scope of Estimate – a brief written description of what the estimate covers.
- Drawings – references the engineering drawings or sketches on which the quantity take-offs are based. Drawing set titles or description and publication date shall be listed.
- Specifications - the specification (if any) that affect quantities provided for the estimate.
- Quantities - indicates how quantities were developed and calculated as well as any limitations.
- Construction Schedule - indicates start and finish dates and sequence of major phases of work pertinent to the estimate.
- Cost Exclusions - a list of any items not included in the estimate that may become a Project expense.
- Estimate Discussion/Comments - identifies any items that can affect either cost or schedule and that have not been covered in any of the above paragraphs. It also lists observations, recommendations, or unusual features of the project, from the estimator's perspective.

Preparation of the Basis of Estimate is the responsibility of the Regional Consultants.

3.4.2 Estimate Reconciliation

Reconciliations will be made between current cost estimates and previous cost estimates. The goal of reconciliation is to identify and document significant changes that have occurred since the preparation of the prior capital cost estimate. Significant changes shall be identified in the reconciliation under one of three categories that best reflects the cause for the change: Quantity, Unit Price, or Scope. These changes shall be referenced to specific line items in the estimate and shall include a brief written description of the change.

The PMT will prepare the 15% Design level capital cost estimate reconciliation with the programmatic capital cost estimate based on input from the Regional Consultants. The 15% cost estimate will serve as the baseline cost for subsequent design phases.

3.5 COST ESTIMATE PRICING METHODS FOR 15% DESIGN

The PMT will develop unit prices based on common methods used for estimating unit prices, including:

- Historical bid prices
- Analysis of production rates, labor and equipment rates, and material costs for each construction activity.

These methods may be used either individually or in combination. For the 15% Design level, when limited engineering details are available, the historical bid price method will typically be used.

3.5.1 Historical Bid Price Method

Historical bid prices will typically be used to develop costs for common construction elements. When using this method, the time of bid and conditions of the historical project used for pricing shall be taken into account and factors applied as needed:

- Adjust bid prices where the bid date is older than 12 months from the current date by using an appropriate escalation factor
- Adjust bid prices to reflect conditions of the project, such as type of terrain, geographical location, soil, traffic and other related factors. For location factor adjustments, the City Cost Index as published by RS Means will be used.

Sources for historical bid prices that will be used may come from local, regional, statewide and national levels, as well as from international high-speed rail projects with unique high-speed elements. Historical unit prices that are used for the CHSTP will be verified for appropriateness and documented as to their source as well as any adjustments for site, escalation or location factors.

3.5.2 Unit Price Analysis Method

The unit price analysis method will typically be used to develop costs for complex construction elements including but not limited to viaducts, retained earth systems, tunneling and underground structures. This method allows for unit prices to be developed based on current local construction and market conditions, such as changes which might affect productivity or the cost of labor or materials. The following steps are required in order to develop a unit price using this method:

- Analyze the proposed construction conditions
- Estimate production rates
- Compile a list of materials
- Obtain materials prices using local available sources
- Determine labor and equipment rates
- Calculate direct unit price using the above factors
- Add allowances for contractor overhead and profit to arrive at a in place unit price

The following sources will be used to obtain basic cost data that is input into the database estimating program in order to develop any needed construction unit prices:

- Labor Rates – Federal Davis-Bacon Wage Determination and/or California Department of Industrial Relations Prevailing Wage Determinations.
- Equipment Rates – RS Means and/or Corp of Engineers Construction Equipment Ownership and Operating Expense Schedule, Region VII.
- Material Prices - Material and supply prices for locally available material will be obtained from local supplier quotes, if possible. Secondary sources of material cost data may be taken from RS Means, Engineering News-Report (ENR) or other published resource.

3.5.3 Contingency

Contingency, in the statistical sense, is the estimated percentage by which a calculated value may differ from its true or final value and is typically included in an estimate as an allowance for the level of engineering design completion or to address imperfections in the estimating methods used at the

various project development stages. Contingency is typically added to a particular item or group of items by the use of percentage multipliers. Contingency is generally greatest for the early stage of project development and decreases with advancement in the level of engineering design and pricing detail. During the preliminary design of the high-speed train project, the limited level of design information that is available requires the use of contingency allowances that are allocated against specific construction or procurement cost categories. The percentage selected for a given cost category are generally based on level of definition of the scope of work involved and substantiated by professional judgment and experience relative to level of uncertainty and historical cost variability typically seen for work within a particular cost category. For the purposes of this estimating program, contingency will be assigned into two major categories – allocated and unallocated.

Allocated contingency will be added based on an assessment of the quality of design information available for individual items of work and will typically fall in a range of 10% to 25%. The exact percentage selected for each cost category is based on professional judgment and experience related to the cost variability typically seen for items of work within a particular cost category. The percentages shown in Table 3-2 are values that will normally be used; however, slightly higher or lower values may be used if a project-specific condition warrants.

Unallocated contingency is typically included to address uncertainties that are more global in nature like schedule delays, changes in contracting environment, or other such issues that are not associated with individual construction activities. Unallocated contingencies will be estimated at 5 percent of the total construction costs.

Table 3-2 Allocated Contingency Percentages by Cost Category

Cost Category No.	Description	Allocated Contingency Percentage
10 Track Structures and Track		
10.01	Track structure: Viaduct	10%
10.02	Track structure: Major/Movable bridges	10%
10.03	Track structure: Undergrade bridges	10%
10.04	Track structure: Culverts and drainage structures	10%
10.05	Track structure: Cut and Fill (> 4' height/depth)	20%
10.06	Track structure: At-grade (grading and subgrade stabilization)	10%
10.07	Track structure: Tunnel	25%
10.08	Track structure: Retaining walls and systems	15%
10.09	Track new construction: Conventional ballasted	15%
10.10	Track new construction: Non-ballasted	15%
10.11	Track rehabilitation: Ballast and surfacing	15%
10.12	Track rehabilitation: Ditching and drainage	15%
10.13	Track rehabilitation: Component replacement (rail, ties, etc)	15%
10.14	Track: Special track work (switches, turnouts, insulated joints)	15%
10.15	Track: Major interlockings	15%
10.16	Track: Switch heaters (with power and control)	15%
10.17	Track: Vibration and noise dampening	15%
10.18	Other linear structures including fencing, sound walls	15%
20 Stations, Terminals, Intermodal		25%
30 Support Facilities: Yards, Shops, Admin. Bldgs		25%
40 Sitework, Right of Way, Land, Existing Improvements		

40.01	Demolition, clearing, site preparation	25%
40.02	Site utilities, utility relocation	25%
40.03	Hazardous material, contaminated soil removal/mitigation, ground water treatments	0%
40.04	Environmental mitigation: wetlands, historic/archeology, parks	20%
40.05	Site structures including retaining walls, sound walls	25%
40.06	Temporary facilities and other indirect costs during construction	0%
40.07	Purchase or lease of real estate	10%
40.08	Highway/pedestrian overpass/grade separations	10%
40.09	Relocation of existing households and businesses	10%
50 Communications & Signaling		15%
60 Electric Traction		15%
70 Vehicles		0%
80 Professional Services		0%

3.5.4 Base Year and Escalation

Estimates will be prepared in Base Year dollars with the Base Year defined as the current calendar year. Unit costs will be updated annually or as required. For cost estimates with a base year that is older than the current calendar by one or more years, actual historical construction cost index values can be used to calculate the escalation rate to be applied to bring a cost from the period in question to the present. A cost estimate prepared in the current base year cost will be projected into a future calendar year by using a cost escalation factor.

There are a wide variety of published construction cost indexes and economic forecasting publications, from both governmental as well as private sources. These indexes are normally calculated using a set of defined construction or procurement commodities that the sponsoring group determines to be representative of the market sector that they are trying to monitor and predict. Some indexes track the in-place constructed cost for a set of commodities that include material, labor and equipment costs plus contractor's overhead and profit. Other indexes may only track certain material prices, labor costs, or the cost of goods and services sold. Another aspect of these indexes that can affect their usefulness is whether they are calculated using regional or national market information.

The CHSTP will consider a number of sources of information including Caltrans Highway Construction Index, California Department of Finance Economic Forecasts, and US Bureau of Labor Statistics Producer Price Index for highway construction, and construction economics data published by *Engineering News- Record* (ENR).

3.5.5 Program Implementation Costs

Program Implementation costs are included to represent the costs of engineering, project and construction management, contract administration, insurance, permits and fees, training/start-up/testing and any force account work. These add-on costs will be calculated as a percentage of construction costs only (applied individually and not cumulatively and excluding vehicle procurement and right-of-way costs) and presented under Professional Services cost category in the estimate.

Program Management	3.0%
Final Design	6.0%
Construction Management	4.0%
Agency Costs	0.5%
Total	13.5%

3.5.6 Estimate Validation

A formal estimate validation meeting will be scheduled to include a select group of project participant's representing the Authority, PMT, Regional Consultants and potentially outside subject matter experts. The purpose of this meeting will be to provide an opportunity to discuss and confirm the design, construction and estimating inputs and assumptions used to prepare the estimate. All changes and adjustments that are accepted at this meeting will then be incorporated before the final estimate submittal. Estimates will be considered a draft until they receive a final review and approval by Authority staff. Authority approval is required prior to the release of any estimate information to anyone other than a project participant.

4.0 SUMMARY AND RECOMMENDATIONS

Recommended methodologies for preparing the 15% Design level capital cost estimate are presented in Section 6.0.

5.0 SOURCE INFORMATION AND REFERENCES

1. Capital Cost Estimating Program Manual – Charlotte Area Transit System (February 2006)
2. Federal Railroad Administration Standard Cost Categories for Capital Projects/Programs*
3. California High-Speed Rail Authority - 2009 Report to the Legislature
4. International Association for the Advancement of Cost Engineering (AACE) - Recommended Practice No. 10S-90 – Cost Engineering Terminology
5. Association for the Advancement of Cost Estimating. International Practice No. 17R-97. Cost Estimate Classification System. TCM Framework: 7.3 – Cost Estimate and Budgeting. 2003.

6.0 DESIGN MANUAL CRITERIA

6.1 ROLES AND RESPONSIBILITIES

Project participants will work on different and/or multiple high-speed train corridors and will be working at varying stages of project development concurrently. Recognizing that the development of capital cost estimates involves the execution and coordination of a number of estimating tasks, one of the critical issues is the assigning of roles and responsibilities for these tasks.

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4	Construction Cost Estimate	R	P	R
5	Property Takes and Easement Qty	-	R	P
6	Right-of-Way Cost Estimate	R	R	P
7	Rolling Stock Procurement Estimate	R	P	-
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9	Program Wide Cost Estimate	R	P	-
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Legend: **P** = Perform Work **R** = Review Work

6.2 ESTIMATING TASKS

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This task involves the development of the Work Breakdown Structure (WBS) that will be applied to cost estimating and cost reporting. The WBS for estimating will include a coding system that will be used for estimating elements such as unit prices, quantities, labor, materials, etc. The WBS for reporting includes the development of a coding system that allows the cost estimates to be sorted and presented by elements such as geographic region, political or municipal boundaries, construction package, schedule activity, and similar project elements.

The WBS of capital cost estimates for the 15% Design level is based upon the FRA Standard Cost Categories. The WBS, inclusive of the standard cost categories, is presented in Appendix A.

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The PMT will prepare a list of prototypical unit cost elements and the units of measure to be estimated for 15% Design level, and will develop corresponding unit prices. Appendix B presents the list of cost elements for the 15% Design Level. Regional Consultants will review unit prices and supporting back-up information developed by the PMT and will provide comments to the PMT followed by metting discussion if necessary to reach concurrence. If required, project-specific unit cost elements reflecting unique site conditions and configurations will be identified and developed by the Regional Consultants and reviewed by the PMT. Examples of these project-specific unit prices include very high and/or long span iconic bridge structures, grade separations, specific roadway improvements, unique utility relocations, staged construction to accommodate existing rail or vehicular traffic, or restrictive site access conditions in urban areas.

6.2.3 Task 3 – Quantity Takeoffs

This task involves preparing estimated quantities, either by direct measurement and calculation of construction elements that are shown in design drawings, electronically calculated for CADD files or established as an allowance quantity based on professional experience and judgment.

No specific methodology will be prescribed for estimating quantities for the 15% Design level. Regional Consultants shall identify and use appropriate source and methodology used for quantity take-offs. The intent is to leave a reviewable trail for quantities to be checked or spot-checked by others.

The PMT will develop a template with the 15% unit cost items and units of measure that the Regional Consultants will use to record and transmit estimated quantities. Regional Consultants will prepare and transmit final quantities in the Unit Cost Summary template prepared by the PMT. Once construction cost estimates are compiled by the PMT, Regional Consultants will review values and allocation of quantities within the estimates and provide written concurrence that subject estimate represent quantities as intended. An example of the sign-off sheet used in documenting this concurrence is included as Appendix C.

6.2.4 Task 4 - Construction Cost Estimate (including Contingency)

This task involves the assembly and calculation of cost estimates for construction related activities using data developed in Tasks 1-3 and procedures described in Section 6.4 Preparation of 15% Cost Estimates, Section 6.5.4 Base Year and Escalation, and Section 6.5.5 Program Implementation, along with the application of appropriate contingencies as presented in Section 6.5.3 Contingency. The PMT will establish baseline contingencies for major cost categories for the 15% Design level, as presented in Table 6-2. Regional Consultants may adjust contingency values, if appropriate, based on information about each of the project's geographic segments. The analysis and selection of appropriate contingencies will be informed by CHSTP risk assessment and risk management practices. The PMT will prepare cost estimates for each environmental segment and program wide estimates based on the contingency values that are agreed upon by the PMT and Regional Consultants.

6.2.5 Task 5 – Property Takes and Easement Quantities

This task involves preparing estimated quantities of impacted properties, either permanent takes or temporary easements, which result from construction, operation, and maintenance of proposed high-speed train alignment alternatives. The identification of property related impacts that need to be quantified must be performed in coordination with the methodology that will be used to develop the right-of-way cost estimates described in Task 6 – Right-of-Way Cost Estimates.

Regional Consultants will be responsible for preparing quantity estimates for property takes and easements.

6.2.6 Task 6 – Right-of-Way Cost Estimate (including Contingency)

This task involves applying professional experience and judgment in the area of property valuation, business damages, and legal and administrative issues as they relate to the estimation of right-of-way costs. The means and methods used to develop these cost estimates will have a direct effect on Task 5 and on how property impacts are identified and quantified.

Regional Consultants will determine appropriate methodologies for determining, quantifying, and estimating real property costs. Regional Consultants will estimate costs to acquire right-of-way and

property interests required for the construction, operation, and maintenance of the high-speed train system.

6.2.7 Task 7 – Rolling Stock Procurement Estimate

This task involves estimating the costs associated with the procurement of rolling stock, including both revenue and non-revenue vehicles. Cost estimates for this task will be dependent on the vehicle technology that is ultimately selected.

The PMT will prepare the rolling stock procurement estimate.

6.2.8 Task 8 – Program Implementation Costs

This task involves establishing percentage add-on allowances for project related professional services for items such as preliminary and final engineering, project and construction management, agency program management, project insurance, commissioning and testing, and project start-up costs. These allowances will be computed by applying percentage factors to the total estimated construction cost (Task 4), excluding right-of-way and rolling stock costs since the total cost for these two items will include the management and administration costs associated with these activities.

The PMT will define the professional service categories and percentage cost factors to be assumed in the capital cost estimates.

6.2.9 Task 9 – Assemble Program Wide Cost Estimate

This task involves compiling and maintaining a program wide cost estimate by combining construction costs (Task 4), right-of-way costs (Task 6), rolling stock procurement costs (Task 7), and applying professional services costs (Task 8) to produce an estimate of the overall CHSTP program.

The PMT will prepare the program wide capital cost estimate based on quantities that are prepared by the Regional Consultants.

6.2.10 Task 10 – Estimate Validation

Following preparation of the 15% Design level estimates, cost estimates will advance through a validation process as outlined in Section 6.5.6 Estimate Validation. This task will assemble subject matter experts in the areas of engineering, construction, and estimating to perform an independent review of the scope, assumptions and basis used to prepare the cost estimate. This process will provide a thorough vetting of each cost estimate before it is finalized.

In collaboration, the PMT and Regional Consultants will validate the 15% Design level cost estimates.

6.3 ESTIMATING METHODOLOGY AND STANDARDS

Multiple designers working concurrently on the project's multiple geographic segments requires that common design basis, criteria and standards; engineering assumptions; design guidance; and directive drawings are used to develop high-speed train alternatives and cost estimate quantities used in preparing the cost estimates. The following are guidelines and standards to be used in preparing the 15% Design level cost estimates.

6.3.1 Design Guidelines and Standards

CHSTP estimates shall be based on design guidelines defined in Technical Memoranda that have been issued or are under development. Criteria, guidelines and assumptions used to identify construction activities in capital cost estimates shall be in accordance with all approved technical memoranda and design guidance documents.

6.3.2 Software

Software for developing and preparing program capital cost estimates include standard spreadsheet programs, such as Microsoft Excel, or commercially produced database estimating programs.

No specific software is prescribed for the estimating quantities and producing cost estimates for the 15% Design level. However, Regional Consultants shall prepare quantities for their respective segments and transmit the information in a template provided by the PMT. This will provide uniformity

between high-speed line segments performed by the Regional Consultants as well as provide a platform to allow for consistent input into program-level estimates.

The PMT shall compile and prepare segment specific and the overall program wide cost estimates using a commercially available database program that will allow for the anticipated reporting and analysis needs of the program-wide cost estimates. The database software will be used primarily as a tool to compile quantities, apply unit prices, contingencies and for reporting.

6.3.3 Coordination with Project Control Functions

There are a number of project controls disciplines that are typically associated with capital cost estimating that must be considered during the development of the CCEM. These include construction scheduling, cost and change control, and risk management.

Regional Consultants are responsible for the coordination between these project control functions, including preparation of construction schedules for their respective sections.

6.4 PREPARATION OF 15% COST ESTIMATE QUANTITIES

The following information shall be included in the 15% Design level cost estimate quantities shall be prepared by the Regional Consultants for each project segment:

- Letter of transmittal
- Basis of estimate
- Estimate reconciliation (if previous estimate exists)
- Estimate summary
- Details of estimate
- Quantity takeoff summary
- Cost Estimate

A description of the information to be included is summarized in the following section.

6.4.1 Basis of Estimate

The Basis of Estimate provides specific information related to the estimate and shall provide the following information:

- Scope of Estimate – a brief written description of what the estimate covers.
- Drawings – references the engineering drawings or sketches on which the quantity take-offs are based. Drawing set titles or description and publication date shall be listed.
- Specifications - the specification (if any) that affect quantities provided for the estimate.
- Quantities - indicates how quantities were developed and calculated as well as any limitations.
- Construction Schedule - indicates start and finish dates and sequence of major phases of work pertinent to the estimate.
- Cost Exclusions - a list of any items not included in the estimate that may become a Project expense.
- Estimate Discussion/Comments - identifies any items that can affect either cost or schedule and that have not been covered in any of the above paragraphs. It also lists observations, recommendations, or unusual features of the project, from the estimator's perspective.

Preparation of the Basis of Estimate is the responsibility of the Regional Consultants.

6.4.2 Estimate Reconciliation

Reconciliations shall be made between current cost estimates and previous cost estimates. The goal of reconciliation is to identify and document significant changes that have occurred since the preparation of the prior capital cost estimate. Significant changes shall be identified in the reconciliation under one of three categories that best reflects the cause for the change: Quantity, Unit Price, or Scope. These changes shall be referenced to specific line items in the estimate and shall include a brief written description of the change.

The PMT will prepare the 15% Design level capital cost estimate reconciliation with the programmatic capital cost estimate based on input from the Regional Consultants. The 15% cost estimate will serve as the baseline cost for subsequent design phases.

6.5 COST ESTIMATE PRICING METHODS FOR 15% DESIGN

The PMT will develop unit prices based on common methods used for estimating unit prices, including:

- Historical bid prices
- Analysis of production rates, labor and equipment rates, and material costs for each construction activity.

These methods may be used either individually or in combination. For the 15% Design level, when limited engineering details are available, the historical bid price method will typically be used.

6.5.1 Historical Bid Price Method

Historical bid prices will typically be used to develop costs for common construction elements. When using this method, the time of bid and conditions of the historical project used for pricing shall be taken into account and factors applied as needed:

- Adjust bid prices where the bid date is older than 12 months from the current date by using an appropriate escalation factor
- Adjust bid prices to reflect conditions of the project, such as type of terrain, geographical location, soil, traffic and other related factors. For location factor adjustments, the City Cost Index as published by RS Means will be used.

Sources for historical bid prices that will be used may come from local, regional, statewide and national levels, as well as from international high-speed rail projects with unique high-speed elements. Historical unit prices that are used for the CHSTP will be verified for appropriateness and documented as to their source as well as any adjustments for site, escalation or location factors.

6.5.2 Unit Price Analysis Method

The unit price analysis method will typically be used to develop costs for complex construction elements including but not limited to viaducts, retained earth systems, tunneling and underground structures. This method allows for unit prices to be developed based on current local construction and market conditions, such as changes which might affect productivity or the cost of labor or materials. The following steps are required in order to develop a unit price using this method:

- Analyze the proposed construction conditions
- Estimate production rates
- Compile a list of materials
- Obtain materials prices using local available sources
- Determine labor and equipment rates
- Calculate direct unit price using the above factors
- Add allowances for contractor overhead and profit to arrive at a in place unit price

The following sources will be used to obtain basic cost data that is input into the database estimating program in order to develop any needed construction unit prices:

- Labor Rates – Federal Davis-Bacon Wage Determination and/or California Department of Industrial Relations Prevailing Wage Determinations.
- Equipment Rates – RS Means and/or Corp of Engineers Construction Equipment Ownership and Operating Expense Schedule, Region VII.
- Material Prices - Material and supply prices for locally available material will be obtained from local supplier quotes, if possible. Secondary sources of material cost data may be taken from RS Means, Engineering News-Report (ENR) or other published resource.

6.5.3 Contingency

Contingency, in the statistical sense, is the estimated percentage by which a calculated value may differ from its true or final value and is typically included in an estimate as an allowance for the level of engineering design completion or to address imperfections in the estimating methods used at the various project development stages. Contingency is typically added to a particular item or group of items by the use of percentage multipliers. Contingency is generally greatest for the early stage of project development and decreases with advancement in the level of engineering design and pricing detail. During the preliminary design of the high-speed train project, the limited level of design information that is available requires the use of contingency allowances that are allocated against specific construction or procurement cost categories. The percentage selected for a given cost category are generally based on level of definition of the scope of work involved and substantiated by professional judgment and experience relative to level of uncertainty and the historical cost variability typically seen for work within a particular cost category. For the purposes of this estimating program, contingency will be assigned into two major categories – allocated and unallocated.

Allocated contingency will be added based on an assessment of the quality of design information available for individual items of work and will typically fall in a range of 10% to 25%. The exact percentage selected for each cost category is based on professional judgment and experience related to the cost variability typically seen for items of work within a particular cost category. The percentages shown in Table 6-2 are values that will normally be used; however, slightly higher or lower values may be used if a project-specific condition warrants.

Unallocated contingency is typically included to address uncertainties that are more global in nature like schedule delays, changes in contracting environment, or other such issues that are not associated with individual construction activities. Unallocated contingencies will be estimated at 5 percent of the total construction costs.

Table 6-2 Allocated Contingency Percentages by Cost Category

Cost Category No.	Description	Allocated Contingency Percentage
10 Track Structures and Track		
10.01	Track structure: Viaduct	10%
10.02	Track structure: Major/Movable bridges	10%
10.03	Track structure: Undergrade bridges	10%
10.04	Track structure: Culverts and drainage structures	10%
10.05	Track structure: Cut and Fill (> 4' height/depth)	20%
10.06	Track structure: At-grade (grading and subgrade stabilization)	10%
10.07	Track structure: Tunnel	25%
10.08	Track structure: Retaining walls and systems	15%
10.09	Track new construction: Conventional ballasted	15%
10.10	Track new construction: Non-ballasted	15%
10.11	Track rehabilitation: Ballast and surfacing	15%
10.12	Track rehabilitation: Ditching and drainage	15%
10.13	Track rehabilitation: Component replacement (rail, ties, etc)	15%
10.14	Track: Special track work (switches, turnouts, insulated joints)	15%
10.15	Track: Major interlockings	15%
10.16	Track: Switch heaters (with power and control)	15%
10.17	Track: Vibration and noise dampening	15%
10.18	Other linear structures including fencing, sound walls	15%

20 Stations, Terminals, Intermodal		25%
30 Support Facilities: Yards, Shops, Admin. Bldgs		25%
40 Sitework, Right of Way, Land, Existing Improvements		
40.01	Demolition, clearing, site preparation	25%
40.02	Site utilities, utility relocation	25%
40.03	Hazardous material, contaminated soil removal/mitigation, ground water treatments	20%
40.04	Environmental mitigation: wetlands, historic/archeology, parks	20%
40.05	Site structures including retaining walls, sound walls	25%
40.06	Temporary facilities and other indirect costs during construction	0%
40.07	Purchase or lease of real estate	10%
40.08	Highway/pedestrian overpass/grade separations	10%
40.09	Relocation of existing households and businesses	10%
50 Communications & Signaling		15%
60 Electric Traction		15%
70 Vehicles		0%
80 Professional Services		0%

6.5.4 Base Year and Escalation

Estimates will be prepared in Base Year dollars with the Base Year defined as the current calendar year. Unit costs will be updated annually or as required. For cost estimates with a base year that is older than the current calendar by one or more years, actual historical construction cost index values can be used to calculate the escalation rate to be applied to bring a cost from the period in question to the present. A cost estimate prepared in the current base year cost will be projected into a future calendar year by using a cost escalation factor.

There are a wide variety of published construction cost indexes and economic forecasting publications, from both governmental as well as private sources. These indices are normally calculated using a set of defined construction or procurement commodities that the sponsoring group determines to be representative of the market sector that they are trying to monitor and predict. Some indices track the in-place constructed cost for a set of commodities that include material, labor and equipment costs plus contractor's overhead and profit. Other indices may only track certain material prices, labor costs, or the cost of goods and services sold. Another aspect of these indices that can affect their usefulness is whether they are calculated using regional or national market information.

The CHSTP will consider a number of sources of information including Caltrans Highway Construction Index, California Department of Finance Economic Forecasts, and US Bureau of Labor Statistics Producer Price Index for highway construction, and construction economics data published by *Engineering News- Record* (ENR).

6.5.5 Program Implementation Costs

Professional services cost add-ons are included to represent the costs of engineering, project and construction management, contract administration, insurance, permits and fees, training/start-up/testing and any force account work. These add-on costs will be calculated as a percentage of construction costs only (excluding vehicle procurement and right-of-way costs) will be developed by the PMT.

6.5.6 Estimate Validation

A formal estimate validation meeting will be scheduled to include a select group of project participant's representing the Authority, PMT, Regional Consultants and potentially outside subject matter experts. The purpose of this meeting will be to provide an opportunity to discuss and confirm the design, construction and estimating inputs and assumptions used to prepare the estimate. All changes and adjustments that are accepted at this meeting will then be incorporated before the final estimate submittal. All estimates will be considered a draft until they receive a final review and approval by Authority staff. Authority approval is required prior to the release of any estimate to anyone other than a project participant.

APPENDIX A WORK BREAKDOWN STRUCTURE (WBS)

WORK BREAKDOWN STRUCTURE (FRA STANDARD COST CATEGORIES)

10 TRACK STRUCTURES & TRACK	
10.01	Track structure: Viaduct
10.02	Track structure: Major/Movable bridge
10.03	Track structure: Undergrade Bridges
10.04	Track structure: Culverts and drainage structures
10.05	Track structure: Cut and Fill (> 4' height/depth)
10.06	Track structure: At-grade (grading and subgrade stabilization)
10.07	Track structure: Tunnel
10.08	Track structure: Retaining walls and systems
10.09	Track new construction: Conventional ballasted
10.10	Track new construction: Non-ballasted
10.11	Track rehabilitation: Ballast and surfacing
10.12	Track rehabilitation: Ditching and drainage
10.13	Track rehabilitation: Component replacement (rail, ties, etc)
10.14	Track: Special track work (switches, turnouts, insulated joints)
10.15	Track: Major interlockings
10.16	Track: Switch heaters (with power and control)
10.17	Track: Vibration and noise dampening
10.18	Other linear structures including fencing, sound walls
20 STATIONS, TERMINALS, INTERMODAL	
20.01	Station buildings: Intercity passenger rail only
20.02	Station buildings: Joint use (commuter rail, intercity bus)
20.03	Platforms
20.04	Elevators, escalators
20.05	Joint commercial development
20.06	Pedestrian / bike access and accommodation, landscaping, parking lots
20.07	Automobile, bus, van accessways including roads
20.08	Fare collection systems and equipment
20.09	Station security
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	
30.01	Administration building: Office, sales, storage, revenue counting
30.02	Light maintenance facility
30.03	Heavy maintenance facility
30.04	Storage or maintenance-of-way building/bases
30.05	Yard and yard track
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	

40.01	Demolition, clearing, site preparation
40.02	Site utilities, utility relocation
40.03	Hazardous material, contaminated soil removal/mitigation, ground water treatments
40.04	Environmental mitigation: wetlands, historic/archeology, parks
40.05	Site structures including retaining walls, sound walls
40.06	Temporary facilities and other indirect costs during construction
40.07	Purchase or lease of real estate
40.08	Highway/pedestrian overpass/grade separations
40.09	Relocation of existing households and businesses
50 COMMUNICATIONS & SIGNALING	
50.01	Wayside signaling equipment
50.02	Signal power access and distribution
50.03	On-board signaling equipment
50.04	Traffic control and dispatching systems
50.05	Communications
50.06	Grade crossing protection
50.07	Hazard detectors: dragging equipment high water, slide, etc.
50.08	Station train approach warning system
60 ELECTRIC TRACTION	
60.01	Traction power transmission: High voltage
60.02	Traction power supply: Substations
60.03	Traction power distribution: Catenary and third rail
60.04	Traction power control
70 VEHICLES	
70.00	Vehicle acquisition: Electric locomotive
70.01	Vehicle acquisition: Non-electric locomotive
70.02	Vehicle acquisition: Electric multiple unit
70.03	Vehicle acquisition: Diesel multiple unit
70.04	Vehicle acquisition: Loco-hauled passenger cars w/ ticketed space
70.05	Vehicle acquisition: Loco-hauled passenger cars w/o ticketed space
70.06	Vehicle acquisition: Maintenance of way vehicles
70.07	Vehicle acquisition: Non-railroad support vehicles
70.08	Vehicle refurbishment: Electric locomotive
70.09	Vehicle refurbishment: Non-electric locomotive
70.10	Vehicle refurbishment: Electric multiple unit
70.11	Vehicle refurbishment: Diesel multiple unit
70.12	Vehicle refurbished: Passenger loco-hauled car w/ ticketed space
70.13	Vehicle refurbished: Non-passenger loco-hauled car w/o ticketed space
70.14	Vehicle refurbishment: Maintenance of way vehicles

70.15	Spare parts
80 PROFESSIONAL SERVICES (applies to Cats. 10-60)	
80.01	Service Development Plan/Service Environmental
80.02	Preliminary Engineering/Project Environmental
80.03	Final design
80.04	Project management for design and construction
80.05	Construction administration & management
80.06	Professional liability and other non-construction insurance
80.07	Legal; Permits; Review Fees by other agencies, cities, etc.
80.08	Surveys, testing, investigation
80.09	Engineering inspection
80.10	Start up
90 UNALLOCATED CONTINGENCY	
100 FINANCE CHARGES	

APPENDIX B UNIT COST CATEGORIES

UNIT COST CATEGORIES

No.	DESCRIPTION	UNIT
10.01	**Track structure: Viaduct**	
10.01.122	Elevated Structure - 1 Track (20' Avg. Pier Ht)	Route Mile
10.01.123	Elevated Structure - 1 Track (30' Avg. Pier Ht)	Route Mile
10.01.124	Elevated Structure - 1 Track (40' Avg. Pier Ht)	Route Mile
10.01.125	Elevated Structure - 1 Track (50' Avg. Pier Ht)	Route Mile
10.01.126	Elevated Structure - 1 Track (60' Avg. Pier Ht)	Route Mile
10.01.127	Elevated Structure - 1 Track (70' Avg. Pier Ht)	Route Mile
10.01.222	Elevated Structure - 2 Track (20' Avg. Pier Ht)	Route Mile
10.01.223	Elevated Structure - 2 Track (30' Avg. Pier Ht)	Route Mile
10.01.224	Elevated Structure - 2 Track (40' Avg. Pier Ht)	Route Mile
10.01.225	Elevated Structure - 2 Track (50' Avg. Pier Ht)	Route Mile
10.01.226	Elevated Structure - 2 Track (60' Avg. Pier Ht)	Route Mile
10.01.227	Elevated Structure - 2 Track (70' Avg. Pier Ht)	Route Mile
10.01.242	Elevated Structure - 4 Track (20' Avg. Pier Ht)	Route Mile
10.01.243	Elevated Structure - 4 Track (30' Avg. Pier Ht)	Route Mile
10.01.244	Elevated Structure - 4 Track (40' Avg. Pier Ht)	Route Mile
10.01.245	Elevated Structure - 4 Track (50' Avg. Pier Ht)	Route Mile
10.01.246	Elevated Structure - 4 Track (60' Avg. Pier Ht)	Route Mile
10.01.247	Elevated Structure - 4 Track (70' Avg. Pier Ht)	Route Mile
10.01.322	Elevated Structure (LS) - 1 Track (20' Avg. Pier Ht)	Route Mile
10.01.323	Elevated Structure (LS) - 1 Track (30' Avg. Pier Ht)	Route Mile
10.01.324	Elevated Structure (LS) - 1 Track (40' Avg. Pier Ht)	Route Mile
10.01.325	Elevated Structure (LS) - 1 Track (50' Avg. Pier Ht)	Route Mile
10.01.326	Elevated Structure (LS) - 1 Track (60' Avg. Pier Ht)	Route Mile
10.01.327	Elevated Structure (LS) - 1 Track (70' Avg. Pier Ht)	Route Mile
10.01.422	Elevated Structure (LS) - 2 Track (20' Avg. Pier Ht)	Route Mile
10.01.423	Elevated Structure (LS) - 2 Track (30' Avg. Pier Ht)	Route Mile
10.01.424	Elevated Structure (LS) - 2 Track (40' Avg. Pier Ht)	Route Mile
10.01.425	Elevated Structure (LS) - 2 Track (50' Avg. Pier Ht)	Route Mile
10.01.426	Elevated Structure (LS) - 2 Track (60' Avg. Pier Ht)	Route Mile
10.01.427	Elevated Structure (LS) - 2 Track (70' Avg. Pier Ht)	Route Mile
10.01.431	Elevated Structure (LS-Tall) - 2-Single Tracks (110' Avg. Pier Ht)	Route Mile
10.01.432	Elevated Structure (LS-Tall) - 2-Single Tracks (120' Avg. Pier Ht)	Route Mile
10.01.512	Elevated Structure Straddle over 2 RR - 1 Track (20' Avg. Pier Ht)	Route Mile
10.01.513	Elevated Structure Straddle over 2 RR - 1 Track (30' Avg. Pier Ht)	Route Mile
10.01.514	Elevated Structure Straddle over 2 RR - 1 Track (40' Avg. Pier Ht)	Route Mile
10.01.515	Elevated Structure Straddle over 2 RR - 1 Track (50' Avg. Pier Ht)	Route Mile
10.01.522	Elevated Structure Straddle over 2 RR - 2 Track (20' Avg. Pier Ht)	Route Mile

10.01.523	Elevated Structure Straddle over 2 RR - 2 Track (30' Avg. Pier Ht)	Route Mile
10.01.524	Elevated Structure Straddle over 2 RR - 2 Track (40' Avg. Pier Ht)	Route Mile
10.01.525	Elevated Structure Straddle over 2 RR - 2 Track (50' Avg. Pier Ht)	Route Mile
10.01.612	Elevated Structure Straddle over 4 RR - 1 Track (20' Avg. Pier Ht)	Route Mile
10.01.613	Elevated Structure Straddle over 4 RR - 1 Track (30' Avg. Pier Ht)	Route Mile
10.01.614	Elevated Structure Straddle over 4 RR - 1 Track (40' Avg. Pier Ht)	Route Mile
10.01.615	Elevated Structure Straddle over 4 RR - 1 Track (50' Avg. Pier Ht)	Route Mile
10.01.622	Elevated Structure Straddle over 4 RR - 2 Track (20' Avg. Pier Ht)	Route Mile
10.01.623	Elevated Structure Straddle over 4 RR - 2 Track (30' Avg. Pier Ht)	Route Mile
10.01.624	Elevated Structure Straddle over 4 RR - 2 Track (40' Avg. Pier Ht)	Route Mile
10.01.625	Elevated Structure Straddle over 4 RR - 2 Track (50' Avg. Pier Ht)	Route Mile
10.01.944	Elevated Structure - 2 Track w/ 2 Single Trenches	Route Mile
10.02	**Track structure: Major/Movable bridge**	
10.02.013	Bridge Structure - 3 span with 1 Track	Route Mile
10.02.023	Bridge Structure - 3 span with 2 Track	Route Mile
10.02.043	Bridge Structure - 3 span with 4 Track	Route Mile
10.05	**Track structure: Cut and Fill (> 4' height/depth)**	
10.05.111	At-Grade Track-bed in Cut - 1 Track (5' Avg. Exc Depth)	Route Mile
10.05.112	At-Grade Track-bed in Cut - 1 Track (10' Avg. Exc Depth)	Route Mile
10.05.113	At-Grade Track-bed in Cut - 1 Track (15' Avg. Exc Depth)	Route Mile
10.05.114	At-Grade Track-bed in Cut - 1 Track (20' Avg. Exc Depth)	Route Mile
10.05.121	At-Grade Track-bed in Cut - 2 Track (5' Avg. Exc Depth)	Route Mile
10.05.122	At-Grade Track-bed in Cut - 2 Track (10' Avg. Exc Depth)	Route Mile
10.05.123	At-Grade Track-bed in Cut - 2 Track (15' Avg. Exc Depth)	Route Mile
10.05.124	At-Grade Track-bed in Cut - 2 Track (20' Avg. Exc Depth)	Route Mile
10.05.126	At-Grade Track-bed in Cut - 2 Track (40' Avg. Exc Depth)	Route Mile
10.05.128	At-Grade Track-bed in Cut - 2 Track (60' Avg. Exc Depth)	Route Mile
10.05.130	At-Grade Track-bed in Cut - 2 Track (80' Avg. Exc Depth)	Route Mile
10.05.132	At-Grade Track-bed in Cut - 2 Track (100' Avg. Exc Depth)	Route Mile
10.05.211	At-Grade Track-bed in Fill - 1 Track (5' Avg. Fill Ht)	Route Mile
10.05.212	At-Grade Track-bed in Fill - 1 Track (10' Avg. Fill Ht)	Route Mile
10.05.213	At-Grade Track-bed in Fill - 1 Track (15' Avg. Fill Ht)	Route Mile
10.05.214	At-Grade Track-bed in Fill - 1 Track (20' Avg. Fill Ht)	Route Mile
10.05.221	At-Grade Track-bed in Fill - 2 Track (5' Avg. Fill Ht)	Route Mile
10.05.222	At-Grade Track-bed in Fill - 2 Track (10' Avg. Fill Ht)	Route Mile
10.05.223	At-Grade Track-bed in Fill - 2 Track (15' Avg. Fill Ht)	Route Mile
10.05.224	At-Grade Track-bed in Fill - 2 Track (20' Avg. Fill Ht)	Route Mile
10.05.226	At-Grade Track-bed in Fill - 2 Track (40' Avg. Fill Ht)	Route Mile
10.05.228	At-Grade Track-bed in Fill - 2 Track (60' Avg. Fill Ht)	Route Mile
10.05.230	At-Grade Track-bed in Fill - 2 Track (80' Avg. Fill Ht)	Route Mile
10.05.232	At-Grade Track-bed in Fill - 2 Track (100' Avg. Fill Ht)	Route Mile
10.06	**Track structure: At-grade (grading and subgrade stabilization)**	
10.06.210	At-Grade Track-bed with Closed Drainage - 1 Track	Route Mile

10.06.220	At-Grade Track-bed with Closed Drainage - 2 Track	Route Mile
10.06.230	At-Grade Track-bed with Closed Drainage - 3 Track	Route Mile
10.06.240	At-Grade Track-bed with Closed Drainage - 4 Track	Route Mile
10.07	**Track structure: Tunnel**	
10.07.101	TBM Single Track Twin Tunnel 30ft ID Unpressurized TBM in hard rock	Route Mile
10.07.102	TBM Single Track Twin Tunnel 30ft ID Slurry TBM in hard rock	Route Mile
10.07.103	TBM Single Track Twin Tunnel 30ft ID in soft ground	Route Mile
10.07.104	TBM Double Track Tunnel 50ft ID in soft ground	Route Mile
10.07.105	TBM Double Track Tunnel 40ft ID in soft ground	Route Mile
10.07.201	D&B Single Track Twin Tunnel 30ft ID in hard rock	Route Mile
10.07.202	D&B Single Track Twin Tunnel 30ft ID in rock	Route Mile
10.07.203	D&B Double Track Tunnel 40ft ID in hard rock	Route Mile
10.07.204	D&B Double Track Tunnel 40ft ID in rock	Route Mile
10.07.205	D&B Double Track Tunnel 50ft ID in hard rock	Route Mile
10.07.206	D&B Double Track Tunnel 50ft ID in rock	Route Mile
10.07.301	SEM Single Track Twin Tunnel 30ft ID in soft ground	Route Mile
10.07.302	SEM Single Track Twin Tunnel 30ft ID in soft ground	Route Mile
10.07.303	SEM Double Track Tunnel 40ft ID in soft ground	Route Mile
10.07.304	SEM Double Track Tunnel 40ft ID in soft ground	Route Mile
10.07.305	SEM Double Track Tunnel 50ft ID in soft ground	Route Mile
10.07.306	SEM Double Track Tunnel 50ft ID in soft ground	Route Mile
10.07.401	RH Single Track Twin Tunnel 30ft ID in soft rock	Route Mile
10.07.402	RH Single Track Twin Tunnel 30ft ID in soft rock	Route Mile
10.07.403	RH Double Track Tunnel 40ft ID in soft rock	Route Mile
10.07.404	RH Double Track Tunnel 40ft ID in soft rock	Route Mile
10.07.405	RH Double Track Tunnel 50ft ID in soft rock	Route Mile
10.07.406	RH Double Track Tunnel 50ft ID in soft rock	Route Mile
10.07.207	D&B Cross Passage conservative cost in rock	Linear Feet
10.07.407	RH Cross Passage conservative cost in soft rock	Linear Feet
10.07.501	Cross Passage in Soft Ground	Linear Feet
10.07.502	Cross Passage in Soft Ground, including jet grout	Linear Feet
10.07.114	Cut & Cover Box - 1 Track/ 1 Box (40' Avg. Exc Depth)	Route Mile
10.07.115	Cut & Cover Box - 1 Track/ 1 Box (50' Avg. Exc Depth)	Route Mile
10.07.116	Cut & Cover Box - 1 Track/ 1 Box (60' Avg. Exc Depth)	Route Mile
10.07.214	Cut & Cover Box - 2 Track / 1 Box (40' Avg. Exc Depth)	Route Mile
10.07.215	Cut & Cover Box - 2 Track / 1 Box (50' Avg. Exc Depth)	Route Mile
10.07.216	Cut & Cover Box - 2 Track / 1 Box (60' Avg. Exc Depth)	Route Mile
10.07.224	Cut & Cover Box - 2 Track/ 2 Box (40' Avg. Exc Depth)	Route Mile
10.07.225	Cut & Cover Box - 2 Track / 2 Box (50' Avg. Exc Depth)	Route Mile
10.07.226	Cut & Cover Box - 2 Track / 2 Box (60' Avg. Exc Depth)	Route Mile
10.07.414	Cut & Cover Box - 4 Track / 1 Box (40' Avg. Exc Depth)	Route Mile
10.07.415	Cut & Cover Box - 4 Track / 1 Box (50' Avg. Exc Depth)	Route Mile
10.07.416	Cut & Cover Box - 4 Track / 1 Box (60' Avg. Exc Depth)	Route Mile
10.07.801	Ventilation Shaft	VF

10.07.802	Mid-Line Ventilation Structure	LS
10.07.803	Tunnel Portal Structure	LS
10.07.805	Emergency Access Shaft	VF
10.07.850	Pumping Station	EA
10.07.901	Mechanical & Electrical Allowance for Underground (Single)	Route Mile
10.07.902	Mechanical & Electrical Allowance for Underground (Double)	Route Mile
10.07.920	Ventilation Equipment Allowance	EA
10.07.922	Double Deck - 2 Track Trench on Top of 2 Track C&C Box	Route Mile
10.07.950	Allowance for Construction Monitoring	Route Mile
10.08	**Track structure: Retaining walls and systems**	
10.08.211	Retained Cut, Trench - 1 Track (10' Avg. Exc Depth)	Route Mile
10.08.212	Retained Cut, Trench - 1 Track (20' Avg. Exc Depth)	Route Mile
10.08.213	Retained Cut, Trench - 1 Track (30' Avg. Exc Depth)	Route Mile
10.08.221	Retained Cut, Trench - 2 Track (10' Avg. Exc Depth)	Route Mile
10.08.222	Retained Cut, Trench - 2 Track (20' Avg. Exc Depth)	Route Mile
10.08.223	Retained Cut, Trench - 2 Track (30' Avg. Exc Depth)	Route Mile
10.08.241	Retained Cut, Trench - 4 Track (10' Avg. Exc Depth)	Route Mile
10.08.242	Retained Cut, Trench - 4 Track (20' Avg. Exc Depth)	Route Mile
10.08.243	Retained Cut, Trench - 4 Track (30' Avg. Exc Depth)	Route Mile
10.08.344	Retained Cut, Staged Trench - 4 Track (40' Avg. Exc Depth)	Route Mile
10.08.346	Retained Cut, Staged Trench - 4 Track (60' Avg. Exc Depth)	Route Mile
10.08.411	Retained Fill, Walls Both Sides - 1 Tracks (10' Avg. Wall Ht)	Route Mile
10.08.412	Retained Fill, Walls Both Sides - 1 Tracks (20' Avg. Wall Ht)	Route Mile
10.08.413	Retained Fill, Walls Both Sides - 1 Tracks (30' Avg. Wall Ht)	Route Mile
10.08.421	Retained Fill, Walls Both Sides - 2 Tracks (10' Avg. Wall Ht)	Route Mile
10.08.422	Retained Fill, Walls Both Sides - 2 Tracks (20' Avg. Wall Ht)	Route Mile
10.08.423	Retained Fill, Walls Both Sides - 2 Tracks (30' Avg. Wall Ht)	Route Mile
10.09	**Track new construction: Conventional ballasted**	
10.09.110	Ballasted Track - 1 Track	Route Mile
10.09.112	Ballasted Track (Track Laying Machine) - 1 Track	Route Mile
10.09.120	Ballasted Track - 2 Track	Route Mile
10.09.122	Ballasted Track (Track Laying Machine) - 2 Track	Route Mile
10.09.240	Ballasted Track - 2 Track (Station Track)	Route Mile
10.09.810	Ballasted Freight Track - 1 Track	Route Mile
10.09.820	Ballasted Freight Track - 2 Track	Route Mile
10.09.910	Ballasted Track Relocation - 1 Track (Temporary)	Route Mile
10.09.920	Ballasted Track Relocation - 1 Track (Permanent)	Route Mile
10.10	**Track new construction: Non-ballasted**	
10.10.110	Direct Fixation Track - 1 Track	Route Mile
10.10.120	Direct Fixation Track - 2 Track	Route Mile
10.10.140	Direct Fixation Track - 4 Track	Route Mile
10.10.210	Independent Dual Block Track - 1 Track	Route Mile
10.10.220	Independent Dual Block Track - 2 Track	Route Mile
10.10.240	Independent Dual Block Track - 4 Track	Route Mile

10.14	Track: Special track work (switches, turnouts, insulated joints)	
10.14.100	Direct Fixation Turnout (60 MPH)	EA
10.14.105	Direct Fixation Turnout (80 MPH)	EA
10.14.110	Direct Fixation Turnout (110 MPH)	EA
10.14.115	Direct Fixation Turnout (150 MPH)	EA
10.14.130	Direct Fixation Crossover (60 MPH)	EA
10.14.135	Direct Fixation Crossover (80 MPH)	EA
10.14.140	Direct Fixation Crossover (110 MPH)	EA
10.14.145	Direct Fixation Crossover (150 MPH)	EA
10.14.200	Ballasted Turnout (60 MPH)	EA
10.14.205	Ballasted Turnout (80 MPH)	EA
10.14.210	Ballasted Turnout (110 MPH)	EA
10.14.215	Ballasted Turnout (150 MPH)	EA
10.14.300	Ballasted Crossover (60 MPH)	EA
10.14.305	Ballasted Crossover (80 MPH)	EA
10.14.310	Ballasted Crossover (110 MPH)	EA
10.14.315	Ballasted Crossover (150 MPH)	EA
10.14.400	Terminal - Bumping Post	
20.01	**Station buildings: Intercity passenger rail only**	
20.01.105	Millbrae Station	LS
20.01.105	Millbrae Station - Site Elements	LS
20.02.200	Redwood/Palo Alto Station	LS
20.02.201	Redwood/Palo Alto Station - Site Elements	LS
20.02.215	Gilroy Station	LS
20.02.216	Gilroy Station - Site Elements	LS
20.02.225	San Jose Station	LS
20.02.226	San Jose Station-Site Elements	LS
20.01.100	Anaheim Station	LS
20.01.110	LA Union Station	LS
20.02.205	Norwalk Station	LS
20.02.206	Norwalk Station - Site Elements	LS
20.02.210	Tulare Station	LS
20.02.211	Tulare Station - Site Elements	LS
20.02.220	Burbank Station	LS
20.02.221	Burbank Station - Site Elements	LS
20.02.230	Merced Station	LS
20.02.231	Merced Station - Site Elements	LS
20.02.235	Fresno Station	LS
20.02.236	Fresno Station - Site Elements	LS
20.02.240	Bakersfield Station	LS
20.02.241	Bakersfield Station - Site Elements	LS
20.02.245	Palmdale Station	LS
20.02.246	Palmdale Station - Site Elements	LS

20.02.250	Sylmar Station	LS
20.02.251	Sylmar Station - Site Elements	LS
20.06	**Pedestrian / bike access and accommodation, landscaping, parking lots**	
20.06.120	Pedestrian Access (Cut & Cover)	LF
20.06.140	Pedestrian Plaza	SF
20.06.160	Pedestrian Access, Vertical Structure, 30' Height	EA
20.06.210	Parking - At Grade	STL
20.06.250	Parking - Structured (Above Grade)	STL
20.06.800	Landscaping Allowance	SF
20.06.810	Landscaping Allowance, Guideway	Route Mile
20.07	**Automobile, bus, van accessways including roads**	
20.07.010	Roadway Modification, New AC Paving	SF
20.07.020	Roadway Modification, New AC Paving (including Curb & Sidewalk)	SF
20.07.710	Permanent Service/Emergency Access Road (20' Wide)	Route Mile
20.07.715	Access Road Entrance Point	EA
20.07.800	Streetscaping Allowance	ESF
30.02	**Light maintenance facility**	
30.02.010	Light Maintenance Facility (LMF)	EA
30.03	**Heavy maintenance facility**	
30.03.010	Heavy Maintenance Facility (HMF)	EA
30.04	**Storage or maintenance-of-way building/bases**	
30.04.010	Maintenance of Way Facility (MOWF)	EA
30.05	**Yard and yard track**	
30.05.110	Ballasted Track - Yard Track	Route Mile
30.05.200	Ballasted Turnout, No. 15	EA
30.05.210	Ballasted Diamond Crossover, No. 15	EA
30.05.250	Heavy Duty Rubber Grade Crossing	TF
40.01	**Demolition, clearing, site preparation**	
40.01.010	Demolition Allowance, Bridge	SF
40.01.050	Demolition Allowance, Building (1 Story)	SF
40.01.060	Demolition Allowance, Building (2 Story)	SF
40.01.110	Demolition Allowance, Asphalt Pavement	SY
40.01.140	Demolition Allowance, Concrete Curb	LF
40.01.150	Demolition Allowance, Concrete Sidewalk	SY
40.01.810	Demolition Allowance, Remove Railroad Track	Route Mile
40.01.900	Miscellaneous Excavation & Support Items	LS
40.02	**Site utilities, utility relocation**	
40.02.001	Utility Relocation Allowance, Level 1	Route Mile
40.02.002	Utility Relocation Allowance, Level 2	Route Mile
40.02.003	Utility Relocation Allowance, Level 3	Route Mile
40.02.004	Utility Relocation Allowance, Level 4	Route Mile
40.02.005	Utility Relocation Allowance, Level 5	Route Mile
40.02.050	Site Utility Allowance	Route Mile

40.03	**Hazardous material, contaminated soil removal/mitigation, ground water treatments**	
40.03.100	Hazardous Material Removal Allowance, Light	Route Mile
40.03.105	Hazardous Material Removal Allowance, Medium	Route Mile
40.03.110	Hazardous Material Removal Allowance, Heavy	Route Mile
40.03.150	Removal of Contaminated Soil	CF
40.04	**Environmental mitigation: wetlands, historic/archeology, parks**	
40.04.100	Environmental Mitigation Allowance, Light	Route Mile
40.04.105	Environmental Mitigation Allowance, Medium	Route Mile
40.04.110	Environmental Mitigation Allowance, Heavy	Route Mile
40.05	**Site structures including retaining walls, sound walls**	
40.05.012	Retaining Wall - 1 Wall (12' Avg. Height)	LF
40.05.111	Containment (Crash) Wall - 1 Wall (6' Avg. Height Above Rail)	LF
40.05.120	Blast Wall (At Stations) - 1 Wall (20' Avg. Height Above Platform)	LF
40.05.211	Sound Wall - 1 Wall (8' Avg. Height)	LF
40.05.310	Intrusion Protection Berm	LF
40.06	**Temporary facilities and other indirect costs during construction**	
40.07	**Purchase or lease of real estate**	
	Right-of-Way Required for Segment	
40.07.100	Dense Urban	Acre
40.07.101	Urban	Acre
40.07.102	Dense Suburban	Acre
40.07.103	Suburban	Acre
40.07.104	Farmland	Acre
40.07.105	Undeveloped	Acre
	Right-of-Way Required for Stations and Maintenance Facilities	
40.07.200	Dense Urban	Acre
40.07.201	Urban	Acre
40.07.202	Dense Suburban	Acre
40.07.203	Suburban	Acre
40.07.204	Undeveloped	Acre
40.08	**Highway/pedestrian overpass/grade separations**	
40.08.322	Roadway Overcrossing HSR - 2 lane retained fill roadway over 2 tracks	EA
40.08.324	Roadway Overcrossing HSR - 4 lane retained fill roadway over 2 tracks	EA
40.08.326	Roadway Overcrossing HSR - 6 lane retained fill roadway over 2 tracks	EA
40.08.342	Roadway Overcrossing HSR - 2 lane retained fill roadway over 4 tracks	EA
40.08.344	Roadway Overcrossing HSR - 4 lane retained fill roadway over 4 tracks	EA
40.08.346	Roadway Overcrossing HSR - 6 lane retained fill roadway over 4 tracks	EA
40.08.422	Roadway Overcrossing HSR - 2 lane roadway on embankment over 2 tracks	EA
40.08.424	Roadway Overcrossing HSR - 4 lane roadway on embankment over 2 tracks	EA
40.08.426	Roadway Overcrossing HSR - 6 lane roadway on embankment over 2 tracks	EA

50.01	**Wayside signaling equipment**	
50.01.010	Train Controls (ATC)	Route Mile
50.01.020	Wayside Protection System	Route Mile
50.05	**Communications**	
50.05.010	Communications (w/Fiber Optic Backbone)	Route Mile
60.02	**Traction power supply: Substations**	
60.02.100	Traction Power Supply	Route Mile
60.03	**Traction power distribution: Catenary and third rail**	
60.03.100	Traction Power Distribution	Route Mile

APPENDIX C CAPITAL COST ESTIMATE SIGN-OFF FORM

CAPITAL COST ESTIMATE SIGN-OFF FORM

ENVIRONMENTAL SEGMENT _____

DESIGN MILESTONE _____

QUANTITIES REVIEWED BY

Signature: _____

Print name: , Regional Consultant Team Date

UNIT PRICES REVIEWED BY

Signature: _____

Print name: , PMT Lead Estimator Date

ESTIMATE REVIEWED BY

Signature: _____

Print name: , PMT Regional Manager Date